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THE ENDURING IMPACT of ancient Greek science and natural philosophy on the civilizations of Islam and Latin Christianity is one of the great success stories in the history of the world. The successful transmission of Greek science into Arabic and then of Greek and Arabic science into Latin compels us to speak of "Greco-Islamic-Latin" science in the Middle Ages. It was Greco-Islamic-Latin science and natural philosophy that unquestionably set the stage for the Scientific Revolution of the seventeenth century, which would otherwise have been impossible. The transmittal of science and natural philosophy from Greek to Arabic and from Greek and Arabic to Latin was largely a one way process, a one-way belt of transmission. There was little, if any, backward movement--that is, there were no meaningful translations from Arabic to Greek and from Latin to Arabic and Greek--and therefore no significant interactions between Western Christianity and Islam.

But if there were no mutual interactions in science and natural philosophy between Latin Christianity and Islam, the two religions on which I shall focus, there were important contrasts in the way each religious tradition responded to, and utilized, the scientific heritage it received. Perhaps the differences in their long-term responses to secular pagan philosophical and scientific learning were shaped to a lesser or greater extent by the culture and civilization in which each was born and the manner in which each came into being.

I

Major Differences that Transcend Science and Natural Philosophy. Christianity was born inside the Roman Empire and was spread slowly and quietly, but persistently. By comparison with Islam, Christianity was disseminated

at a snail's pace. Not until 300 years after the birth of Christ was Christianity effectively represented throughout the Roman Empire. Only in 313, by the Edict of Milan, or Edict of

Toleration, was Christianity given full equality with other religions in the Empire. And it was not until 392--almost four centuries after the birth of Christ--that Christianity became the state religion, when the Emperor Theodosius ordered the closing of pagan temples and forbade pagan worship.

In striking contrast, Islam was spread over an enormous geographical area in a remarkably short time. In less than one hundred years after the death of Muhammad in 632, Islam became the dominant religion in a vast area stretching from the Straits of Gibraltar in the West to India in the East. Such a rapid spread could only have occurred by conquest. Where Christianity spread slowly, by proselytizing, Islam came from outside the Roman world as an alien intruder, and although its converts were pagans and often former Christians, the mind set of the invaders was one which viewed Greek learning as alien, as is illustrated by the fact that Muslims distinguished two kinds of sciences: the Islamic sciences, based on the Koran and Islamic law and traditions, and the foreign sciences, or "pre-Islamic" sciences, which encompassed Greek science and natural philosophy. We might say that the slow spread of Christianity provided Christians an opportunity to adjust to Greek secular learning, whereas Islam's rapid dissemination made its relations with Greek learning much more problematic.

Another dramatic difference concerns the relationship between church and state. From the outset, Christianity recognized the state as distinct from the church. The separation is encapsulated in these momentous words of Jesus: "Render therefore unto Caesar the things which are Caesar's; and unto God the things that are God's" (Matt. 22:21). Thus did Jesus acknowledge the state and implicitly urge his followers to be good citizens. Although Church and state were contending powers throughout the Middle Ages, each acknowledged the independence of the other. They regarded themselves as two swords, although, all too often, they were pointed at each other. Even when the church asserted supremacy over the state, however, it never attempted to establish a theocracy by appointing bishops and priests who were also to function as secular rulers. The tradition of the Roman state within which Christianity developed and the absence of explicit biblical support for a theocratic state were powerful constraints on unbridled and grandiose papal ambitions and, above all, made the imposition of a theocratic state implausible.

In Islam church and state are one. Religion cannot be understood apart from politics, and vice versa. (1) "The function of the state was to guarantee the well-being of the Muslim religion, so that all who lived within the state could be good, practicing Muslims." (2) Where religion is strong, as it was in medieval Islam, it is likely to dominate secular activities, such as natural philosophy. To avoid this consequence, at least one of the following conditions would be essential: (1) regard natural philosophy as a discipline that is distinct and independent from theology; or (2) a secular state protects natural philosophy; or (3) religious authorities regard natural philosophy favorably. While we shall see that the first and third conditions were met in

the Latin West, none of the three conditions was met in medieval Islam.

A third significant difference between Islam and the medieval Christian West is organizational and structural. Islam has no overriding, central authority to determine its orthodoxy, whereas the Latin West had the papacy to insure adherence to the faith and to combat heresy. In brief, Islam is a kind of democratic religion that relies on consensus, whereas medieval Christendom was a centralized religion, headed by a single individual, the Pope, who, in principle, had supreme authority to determine and shape religious opinion and belief. From such a major structural difference, one might suppose that papal-dominated, centralized Christianity would have been far more restrictive and oppressive toward secular Greek learning than consensus-seeking Islam. The record shows, however, that the Church was favorably disposed toward secular learning, especially Aristotelian natural philosophy. In Islam, however, Aristotelian natural philosophy and the philosophers who studied it were often treated with hostility. As we shall see, it was in Islam, rather than in the Latin West, that secular learning, philosophy, and, the "foreign sciences" in general, were subject to significant constraints and confronted considerable obstacles and prejudice.

Although there are hadiths, or traditions, in Islam that praise the unending quest for knowledge, "implying the endlessness of knowledge itself," (3) there are others that see a world that is steadily deteriorating. At least two hadiths express this attitude. In the first, the Prophet proclaims that "time has come full circle back to where it was on the day when first the heavens and the earth were created," and in the second he declares that "The best generation is my generation, then the ones who follow and then those who follow them." (4) Both hadiths were often cited and commentaries were made upon them. "They suggest a universe running down, an imminent end to man and all his works." (5) Such hadiths may have served as powerful elements in Islamic thought and custom. They may have encouraged those who sought to preserve the status quo, or who wished to turn the clock back as far as possible to create a society as close as possible to that which existed in the days of the Prophet Muhammad. It is plausible to suppose that such hadiths exerted an influence on attitudes toward Greek science and natural philosophy, the foreign sciences, which did not exist within Islam when it began.

Indeed, the influence of such hadiths may have affected the way Islam responded to the invention of the printing press. Although it takes us beyond the Middle Ages, it is relevant to mention the time and manner in which printing was introduced into Islam. Although the printing press had been in use in the West since around 1460, and its virtues were obvious, it was not introduced into Islam until 1727, (6) when Ibrahim Muteferrika, described as "a renegade from the Hungarian nobility," (7) established the first press. Even when introduced, the forces that had always opposed it exacted a price: only secular works could be printed, not sacred texts, including the Koran. In *The Ottoman Centuries*, Lord Kinross declares that

With the aid of a committee of twenty-five translators, he [Muteferrika] published a flow of works revealing to his adopted compatriots the mysteries of such objects of study as geography and cartography, in which he himself specialized; physics and astronomy, including a translation of Aristotle with information for the first time on the telescope and microscope, on magnetism and the compass, on the theories of Galileo; on mathematics in its various branches, with the discussion of the ideas of Descartes; and finally on medicine. (8) As an indication that the Ottoman government still did not realize the power of the printing press, Muteferrika's death in 1745 resulted in the cessation of printing until 1783, a hiatus of nearly 40 years. (9) There are undoubtedly other significant differences between Islam and Christianity, but we must now narrow our focus. Although Greek science and natural philosophy may have been regarded as foreign sciences in Islam, most of Greek science and natural philosophy were translated into Arabic and studied over the centuries. Scholars in the Islamic world made significant contributions to science and natural philosophy. Indeed, from around 1100 to 1500, sciences such as optics, astronomy, mechanics, mathematics, and medicine reached a higher state in Islam than in the medieval West. In what follows, however, I shall ignore the exact sciences, which posed no significant doctrinal problems for Islam or Christianity, and focus rather on natural philosophy, almost exclusively Aristotle's natural philosophy, which did indeed pose major problems for Islam and Christianity.

During the Middle Ages, Aristotelian natural philosophy was inherently more important than any single identifiable exact science. In the broadest sense, natural philosophy was the study of change and motion in the physical world. It was one of Aristotle's three subdivisions of theoretical knowledge, or knowledge for its own sake. As the very name suggests, the domain of natural philosophy was the whole of nature. It did not represent any single science, but could, and did, embrace bits and pieces of all sciences. In this sense, natural philosophy was "The Mother of All Sciences." But medieval natural philosophy was far more significant than is indicated by the mere fact that embedded within it were bits and pieces of different modern sciences. In a culture such as that of the Middle Ages, in which the tools for scientific research and inquiry were largely absent, how could nature be interpreted and analyzed in order to arrive at some understanding of a world that would otherwise be unknowable and inexplicable? The most powerful weapon available was human reason, employed in the manner that Aristotle had used it. The idea was to come to know what things seemed to be--and this could be done by empirical means--and then to determine what made them that way, a process that was largely guided by metaphysical and apriori considerations. In the ancient and medieval worlds, Aristotle's works represented the apotheosis of reason. Without reason, science cannot exist. It is the first indispensable element in the development of science and it was the characteristic feature of medieval natural philosophy. For these reasons, a comparison of the status of natural philosophy in medieval Islam and in the Latin West should tell us much about the potentiality for science within each civilization, and therefore provide some insight into a perennially perplexing

question: why did Islam, which reached a higher state of scientific development in the Middle Ages than the Latin West, fail to continue its development, while the West, which started much later, surpassed Islam by 1600. One major result of any comparison between the relations of these two religions to Aristotelian natural philosophy will reveal that, in contrast with the West, Aristotelian natural philosophy in Islam had an uneasy and uneven existence. Let us see why.

II

Islam. Throughout the history of medieval Islam, the role of Greek philosophy was problematic. At any particular time, there were those who viewed it favorably, while others, undoubtedly a considerable majority, viewed it, at best, with indifference, and perhaps even with some degree of hostility. Occasionally the attitude of this or that caliph was instrumental in altering attitudes toward natural philosophy, but more often attitudes toward natural philosophy and Greek thought were governed by Muslim religious leaders, who exercised great influence in particular regions or cities. Not only was Greek philosophy regarded as a foreign science, but the term philosopher (faylasufs) was often employed pejoratively.

In the intellectual hierarchy of medieval Islamic society, scholars distinguish three levels. (10) Because Islam was a nomocracy, the first level was comprised of legal scholars. The religious law and traditions were valued above all else, and, therefore, valued even more than theology. Next in order came the mutakallimun, scholars who used Greek philosophy to interpret and defend the Muslim religion. The mutakallimun emphasized rational discourse, to which they added the authority of revelation. And, finally, at the bottom, were the falasifa, the Islamic philosophers, who followed rational Greek thought, especially the thought of Aristotle. Not surprisingly, the philosophers placed greatest reliance on reasoned argument while downplaying revelation. The philosophers sought to develop natural philosophy in an Islamic environment, and, as Abdelhamid I. Sabra has put it, did so, "often in the face of suspicion and opposition from certain quarters in Islamic society." (11)

Of the three Islamic groups just distinguished, namely legal scholars, who were almost always traditionalists, the mutakallimun, and philosophers, the traditionalists made no real use of Greek philosophy, largely because they found it a threat to revealed truth and the Islamic faith. In their bitter struggle with each other and with the traditionalists, the mutakallimun and the philosophers made much use of Greek philosophy. The mutakallimun were primarily concerned with the Kalam, which, according to Sabra, is "an inquiry into God, and into the world as God's creation, and into man as the special creature placed by God in the world under obligation to his creator." (12) Thus Kalam is a theology that used Greek philosophical ideas to explicate and defend the Islamic faith.

Two groups of mutakallimun have been identified: the Mu'tazilites, who were the more extreme, and the Ash'arites. (13) Both groups shared an attitude "against the passive acceptance of authority in matters of faith." It was their intention to replace the "passive acceptance of authority" with "a state of knowledge ('ilm) rooted in reason." (14) The Mu'tazilites were regarded as Islamic rationalists who equated the power of reason with that of revelation. (15) They are said to have "made an outstanding contribution to Islamic thought by the assimilation of a large number of Greek ideas and methods of argument." (16) These arguments and methods were not adopted for their own sake but rather for their utility in understanding the Islamic religion. In the ninth century, the Mu'tazilites gained the support of caliphs like al-Mamun and Mutassim, as well as influential intellectuals. The supportive caliphs persecuted those who opposed the Mu'tazilite belief that the Koran was created. They implemented a virtual inquisition. Because many thought their rationalism was extreme, the Mu'tazilites were regarded as heretics by many Sunni Muslims. (17) Their ascendancy ended with the rule of the Sunni caliph al-Mutawakkil, who destroyed their movement. (18)

The Asharites, who followed the teaching of al-Ash'ari (d. 935), are the second group of mutakallimun. They broke with Mu'tazilism and replaced it as the main representatives of kalam. Ash'arism, however, was a complicated movement, with some of its followers emphasizing rationalism, while others argued in the traditionalist mode. (19) Although the mutakallimun, both Mutazilites and Asharites, were severe critics of the philosophers, they were, in turn, themselves regarded as too rational and were bitterly opposed by more conservative Muslims, both from the Sunni and Shiite sides.

In treating of attitudes toward natural philosophy and science in medieval Islam, it is essential to have a good sense of the relationships between Muslim traditionalism and Muslim rationalism, which were engaged in an ongoing, and bitter, struggle about the role of Islam in intellectual life. George Makdisi provides a useful way to distinguish between Muslim traditionalism and Muslim rationalism by explaining that:

The traditionalists made use of reason in order to understand what they considered as the legitimate sources of theology: scripture and tradition. What they could not understand they left as it stood in the sources; they did not make use of reason to interpret the sources metaphorically. On the other hand, the rationalists advocated the use of reason on scripture and tradition; and all that they deemed to contradict the dictates of reason they interpreted metaphorically in order to bring it into harmony with reason. (20) The antithetical approaches of the Muslim traditionalists and the Muslim rationalists can be illustrated directly from the

mutakallimun themselves, namely from the Mutazilites and Asharites. What was one to make of anthropomorphic statements in the Koran that speak of "the face of Allah, His eyes and hands, His sitting on His throne, and His being seen by the Faithful in Paradise." (21) The strong tendency in Islam was to take such statements literally. Thus al-Ash'ari himself, for whom reason in theology was still important, declared that:

We confess that God is firmly seated on His throne.... We confess that God has two hands, without asking how.... We confess that God has two eyes, without asking how.... We confess that God has a face.... (22) Mutazilites, however, viewed these same statements metaphorically. God has no bodily parts; He has no parts or divisions; He is not finite. They also say that "He cannot be described by any description which can be applied to creatures, in so far as they are created... The senses do not reach Him, nor can man describe Him by analogy Eyes do not see Him, sight does not reach Him, phantasy cannot conceive Him nor can He be heard by ears." (23) I am unaware of any analogous discussion in the Christian West during the Middle Ages. Medieval Latin theologians regarded anthropomorphic descriptions of God as metaphorical pronouncements.

III

The Philosophers. Of the three groups distinguished earlier, the least popular were the philosophers, whom the mutakallimun and conservative Muslims attacked because they used natural philosophy and logic to acquire truth for its own sake, which usually signified that they were ignoring religion. One of the most significant Ash'arite thinkers, the famous al-Ghazali (1058-1111), leveled a devastating attack against philosophy. He was fearful of the detrimental effects on the Islamic religion of subjects like natural philosophy, theology (actually metaphysics), logic, and mathematics. In his famous quasi-autobiographical treatise, *Deliverance from Error*, he explained that religion does not require the rejection of natural philosophy, but that there are serious objections to it because nature is completely subject to God, and no part of it can act from its own essence. The implication is obvious: Aristotelian natural philosophy is unacceptable because it assumes that natural objects can act by virtue of their own essences and natures. That is, Aristotle believed in secondary causation--that physical objects are capable of causing effects in other physical objects. Al-Ghazali found mathematics dangerous because it uses clear demonstrations, thus leading the innocent to think that all the philosophical sciences are equally lucid. A man will say to himself, al-Ghazali related, "if religion were true, it would not have escaped the notice of these men [that is, the mathematicians] since they are so precise in this science." (24) Ghazali explains further that such a man will be so impressed with what he hears about the techniques and demonstrations of the mathematicians that "he draws the conclusion that the truth is the denial and rejection of religion. How many have I seen," al-Ghazali continues, "who err from the truth because of this

high opinion of the philosophers and without any other basis." (25) Although al-Ghazali allowed that the subject matter of mathematics is not directly relevant to religion, he included the mathematical sciences within the class of philosophical sciences (these are: mathematics, logic, natural science, theology or metaphysics, politics, and ethics) and concluded that a student who studied these sciences would be "infected with the evil and corruption of the philosophers. Few there are who devote themselves to this study without being stripped of religion and having the bridle of godly fear removed from their heads." (26)

In his great philosophical work, *The Incoherence of the Philosophers*, al-Ghazali attacked ancient philosophy, especially the views of Aristotle. He did this by describing and criticizing the ideas of al-Farabi and Avicenna, two of the most important Islamic philosophical commentators on Aristotle. After criticizing their opinions on twenty philosophical problems, including the eternity of the world, that God knows only universals and not particulars, and that bodies will not be resurrected after death, al-Ghazali declares:

All these three theories are in violent opposition to Islam. To believe in them is to accuse the prophets of falsehood, and to consider their teachings as a hypocritical misrepresentation designed to appeal to the masses. And this is blatant blasphemy to which no Muslim sect would subscribe. (27) Al-Ghazali regarded theology and natural philosophy as dangerous to the faith. He had an abiding distrust of philosophers and praised the "unsophisticated masses of men," who "have an instinctive aversion to following the example of misguided genius." Indeed, "their simplicity is nearer to salvation than sterile genius can be." (28) As one of the greatest and most respected thinkers in the history of Islam, al-Ghazali's opinions were not taken lightly. In light of al-Ghazali's attack on the philosophers, it is not surprising to learn that philosophers were often subject to persecution by religious leaders. Many religious scholars regarded philosophy, logic and the foreign Greek sciences generally, as useless, and even ungodly, because they were not directly useful to religion. Indeed, they might even make one disrespectful of religion. (29) In the thirteenth century, Ibn as-Salah ash-Shahrazuri (d. 1245), a religious leader in the field of tradition (hadith), declared in a fatwa that "He who studies or teaches philosophy will be abandoned by God's favor, and Satan will overpower him. What field of learning could be more despicable than one that blinds those who cultivate it and darkens their hearts against the prophetic teaching of Muhammad." (30) Logic was also targeted, because, as Ibn as-Salah, put it, "it is a means of access to philosophy. Now the means of access to something bad is also bad." (31) Ibn as-Salah was not content to confine his hostility to words alone. In a rather chilling passage, he urges vigorous action against students and teachers of philosophy and logic, because:

Those who think they can occupy themselves with philosophy and logic merely out of personal interest or through belief in its usefulness are betrayed and duped by Satan. It is the duty of the civil authorities to protect Muslims against the evil that such people can cause. Persons of this sort must be removed from the schools and punished for their cultivation of these fields. All those who give evidence of pursuing the teachings of philosophy must be confronted with the following alternatives: either (execution) by the sword or (conversion to) Islam, so that the land may be protected and the traces of those people and their sciences may be eradicated. May God support and expedite it. However, the most important concern at the moment is to identify all of those who pursue philosophy, those who have written about it, have taught it, and to remove them from their positions insofar as they are employed as teachers in schools. (32)

Although numerous others shared the attitude of Ibn as-Salah, logic continued to be used as an ancillary subject in scholastic theology (Kalam) and in many orthodox religious schools. But there was enough hostility toward philosophy and logic in Islam to prompt philosophers to keep a low profile. Those who taught did so privately to students who might have sought them out. Following the translations in the early centuries of Islam, Greek philosophy, primarily Aristotle's, received its strongest support from a number of individuals scattered about the Islamic world. Numbered among the greatest of Islamic natural philosophers are al-Kindi (801-873); Al-Razi (ca. 854-925 or 935); Ibn Sina (Avicenna) (980-1037); and Ibn Rushd (Averroes) (1126-1198). All were persecuted to some extent. Al-Kindi's case reveals important aspects of intellectual life in Islam. The first of the Islamic commentators on Aristotle, al-Kindi was at first favorably received by two caliphs (al-Mamun and al-Mu tassim), but his luck ran out with al-Mutawakkil, the Sunni caliph mentioned earlier. According to Pervez Hoodbhoy,

It was not hard for the ulema to convince the ruler that the philosopher had very dangerous beliefs. Mutawakkil soon ordered the confiscation of the scholar's personal library.... But that was not enough. The sixty year old Muslim philosopher also received fifty lashes before a large crowd which had assembled. Observers who recorded the event say the crowd roared approval with each stroke. (33)

The other four scholars were also subjected to some degree of persecution and a number of them had to flee for their safety. Persecutions and harassment of those who advocated the use of reason to explicate revelation are unknown in the medieval Latin West after the mid-twelfth century, when Bernard of Clairvaux and other traditional theologians opposed the application of reason to theology. Bernard undoubtedly had much in common with Islamic traditionalist theologians. In his relentless assault on Peter Abelard, Bernard was convinced that Abelard's heresies, as he saw them, were the result of an excessive reliance on reason, as he makes clear in a letter to a Cardinal of the Church. "He has defiled the Church," Bernard declares,

[H]e has infected with his own blight the minds of simple people. He tries to explore with his reason what the devout mind grasps at once with a vigorous faith. Faith believes, it does not dispute. But this man, apparently holding God suspect, will not believe anything until he has

first examined it with his reason. (34) Bernard's hostile attitude lingered on into the first forty years of the thirteenth century, but only at the University of Paris (though not at Oxford), where Church authorities first banned the books of Aristotle from public or private use, then sought unsuccessfully to censor them. By the 1240's, however, Aristotle's books of natural philosophy were taught and read at the University of Paris. Indeed, they had become the core of the curriculum in the arts faculty of that great medieval university. (35) After the 1240's, and for the rest of the Middle Ages, attacks on reason would have been regarded as bizarre and unacceptable. Some theologians were opposed to certain of Aristotle's ideas, but, like St. Bonaventure, they used Aristotelian natural philosophy, and fully recognized that they could not do theology without it. Scholars were sometimes accused of heresy, and occasionally the Church tried to curb the excessive use of logic and natural philosophy in theological treatises, but I know of no instance where religious authorities sought to prevent the study of natural philosophy because it threatened religion. Indeed, as time passed, Aristotelian natural philosophy only became more entrenched in the medieval universities. By the time of the Galileo affair in the seventeenth century, the Church went to great lengths to defend and protect Aristotle's natural philosophy. How different it was in Islam, if we judge by a question that Averroes posed in the twelfth century in his treatise *On The Harmony of Religion and Philosophy*. In this treatise, Averroes seeks to determine "whether the study of philosophy and logic is allowed by the [Islamic] Law, or prohibited, or commanded--either by way of recommendation or as obligatory." (36) In the thirteenth century, Ibn as-Salah ash-Shahrazuri, an expert on the tradition of Islam and whom we have already met, issued a written reply (fatwa) to a question which asked, in Ignaz Goldziher's words,

whether, from the point of view of religious law, it was permissible to study or teach philosophy and logic and further, whether it was permissible to employ the terminology of logic in the elaboration of religious law, and whether political authorities ought to move against a public teacher who used his position to discourse on philosophy and write about it. (37) What is remarkable in all this is the fact that in the twelfth century, Averroes, and in the thirteenth century, Ibn as-Salah, were grappling with the question whether, from the standpoint of the religious law, it was legitimate to study science, logic, and natural philosophy, even though these disciplines had been readily available in Islam since the ninth century. Averroes felt compelled to justify their study, while Ibn as-Salah, astonishingly, denied their legitimacy. I know of no analogous discussions in the Late Latin Middle Ages in which any natural philosopher or theologian felt compelled to determine whether the Bible permitted the study of secular subjects. It was simply assumed that it did.

The Madrassas and the Universities. Despite the enormous obstacles faced by Islamic natural philosophers and scientists, either in the form of active harassment and even persecution, or simply as indifference, the remarkable feature about medieval Islamic science and natural philosophy was the high level they attained. As I have already mentioned the level of achievement in the sciences between 1100 and 1500 was higher in Islam than in the Christian West. It is more difficult to compare natural philosophy, partly because the Latin West derived some of its ideas from Islamic treatises. In the exploration of Aristotle's works and in the departures they made from Aristotle's thought, the West may have advanced beyond Muslim scholars. But in other ways, certain Muslim scholars went beyond anything contemplated in the West. This is especially true in the attitudes of some Islamic natural philosophers toward theologians and religion.

For example, al-Razi (ca. 854-925 or 935), known as Rhazes in the West, was a famous physician whose major medical work was translated into Latin. He actually attacked religion, denying miracles attributed to the prophets of Islam, Judaism, and Christianity (he is said to have written a treatise titled *The Tricks of the Prophets*). He refused to accept authority in either religion or science and believed that the sciences continually progressed because scientists build upon the knowledge they inherit from their predecessors. He accepted an atomic theory of matter akin to that of Democritus. Because of his independent views, al-Razi was severely criticized by his successors and many of his works have disappeared. (38) Avicenna thought, in the words of Shlomo Pines, that al-Razi "should have confined himself to dealing with boils, urine, and excrement and should not have dabbled in matters beyond the range of his capacity." (39)

Averroes (Ibn Rushd) wrote famous commentaries on Aristotle, which are known only in Latin or Hebrew translations. He is unusual because in his treatise *On the Harmony of Religion and Philosophy*, he insisted that only the philosophers are competent to judge Scripture, because they use demonstrative arguments. By contrast, the mutakallimun are incompetent to do so because they use dialectical reasoning based on popularly accepted premises. (40) The kind of hostility that al-Razi and Averroes showed to the theologians, as well as al-Razi's attacks on religion, have no counterparts in the medieval West.

By contrast, Ibn Khaldun (1332-1406) was more like al-Ghazali and defended religion against philosophy and logic. But his great fame does not derive from any defense of religion against the foreign sciences. Rather, it derives from his extraordinary treatise, known as the *Muqaddima* ("The Introduction"), which consisted of the introduction and first book of a lengthy world history. According to Franz Rosenthal, "The *Muqaddima* was indeed the first large-scale attempt to analyze the group relationships that govern human political and social organization on the basis of environmental and psychological factors." (41) Arnold Toynbee spoke in superlative terms about Ibn Khaldun, declaring that in his *Muqaddima* "he has conceived and formulated a

philosophy of history which is undoubtedly the greatest work of its kind that has ever yet been created by any mind in any time or place." (42) George Sarton's assessment is more critical, but nonetheless highly laudatory. Sarton did not rate Ibn Khaldun as a great historian, but regarded him as:

the greatest theorician of history, the greatest philosopher of man's experience, not only of the Middle Ages, but of the whole period extending from the time of the great classical historians down to that of Machiavelli (1532), Bodin (1576), and even Vico (1725). Badly composed as the *Muqaddama* is, with many repetitions, and poorly written sometimes to the point of obscurity, it remains one of the noblest and most impressive monuments of medieval thought. A comparison between Ibn Khaldun and Machiavelli is not to the disadvantage of the earlier writer. (43) Although comparisons are difficult, there is no reason to believe that Islamic natural philosophers were inferior to those in the Latin West in the late Middle Ages. But the fate of natural philosophy in Islam differed radically from that in the West. To gain a proper sense of the difference, we must compare the madrasas in Islam with the universities in the West. A madrasa was a charitable trust, which was established freely by an individual Muslim, known as a *waqif*, who endowed the trust with substantial funds to be used for a public purpose. The founder had great latitude in determining the conditions for the operation of the madrasa he had founded with his own property. "The legal status of the madrasa allowed the founder to retain complete control over the administrative and instructional staff of the institution." (44) But the founder of a madrasa had to accept one condition: the terms of the foundation could not violate the tenets of Islam. (45) The madrasa was essentially a school for the study of the religious sciences and subordinate and related subjects. Excluded from its curriculum were the "foreign sciences," that is the philosophical and natural sciences. (46) Those who wished to study natural philosophy or the sciences for their own sakes had to either teach themselves, or make arrangements for private instruction with someone knowledgeable in such matters. (47) Occasionally nonreligious courses were taught in the madrasas on an optional basis. In his splendid book, *The Mantle of the Prophet*, Roy Mottahedeh explains that

Madreseh learning had formerly been a conspectus of higher learning, with its optional courses in Ptolemaic astronomy, Avicennian medicine, and the algebra of Omar Khayyam. But ... even the mullahs recognized that their learning really was 'religious' learning, and only a few enthusiasts studied the traditional nonreligious sciences such as the old astronomy in private. (48) However, those subjects were only taught which illuminated the Koran or the religious law. One such subject was logic, which was found useful in semantics and in avoiding "simple errors of inference," although philosophical logic, popular in the West, was usually avoided. (49) The primary function of the madrasa, however, was "to preserve learning and defend

orthodoxy." (50) In Iran, the madrasas existed into the twentieth century, limping on until the end of World War II.

V

The Medieval University in the Latin West. Apart from a few works of Aristotle's logic, the Christian West had virtually no knowledge of Aristotle's natural philosophy for approximately 1100 years after the birth of Christianity. It was not until the twelfth and thirteenth centuries that it made the bulk of Greek natural philosophy and science a part of its intellectual heritage. Islam began its serious appropriation of Greek science in less than two centuries after its founding and by 1000 had translated into Arabic virtually all that it would receive.

But if the West took approximately 1100 years to receive Aristotle's natural philosophy, where Islam acquired it in only two to three hundred years, the West wasted no time in making the most of what it received. By 1200, the new translations facilitated the transition from the Cathedral school system to the university system, represented initially by the universities of Paris, Oxford and Bologna. Despite some difficulties at the University of Paris, the new universities, and numerous others that would follow in the course of the next three centuries--approximately 75 existed by 1500--unhesitatingly chose Aristotle's logic and natural philosophy to form the curriculum of their arts faculties. In a complete university, we find four faculties: arts, theology, medicine, and law. All students were required to obtain a bachelor's degree in arts. If they wished to enter one of the three higher faculties of theology, medicine, and law, they were expected to obtain the Master of Arts degree. This meant that virtually all, if not all, theologians, physicians, and lawyers had been thoroughly trained in logic and natural philosophy, as were those who were content to acquire only a master of arts degree and therefore did not enter one of the three higher faculties. A university education in the Middle Ages was in no way intended to teach religion or theology. Theology was only taught in theology faculties to theology students. It was a jealously guarded intellectual preserve. (51)

Because all theologians were thoroughly trained in logic and Aristotle's natural philosophy, they used these subjects extensively in their theological commentaries, which all theological students were expected to produce. They posed questions that were answerable only by the application of logic and natural philosophy. One of the most powerful logical tools theologians used was the

law of non-contradiction where it was assumed that not even God could perform a contradiction. Richard of Middleton, for example, asks "whether God could do contradictory things simultaneously," (52) and concludes that He cannot. Theologians incessantly inquired whether God could perform this or that act. Their object was to determine whether God could or could not do something by applying the law of non-contradiction. If no contradiction was involved, God could perform the act; if there was a contradiction He could not. For example, Hugolin of Orvieto, in the fourteenth century, applied the law of noncontradiction to determine "Whether God could make the future not to be?" (53) and "Whether God could make a creature exist for only an instant?" (54) and Gregory of Rimini applied it to a question in which he inquired whether God could make someone sin. (55)

During the Latin Middle Ages theology became an analytical discipline with a heavy emphasis on logic and natural philosophy. Indeed, to the extent that medieval theologians increased the analytic content of their theological treatises, they seem simultaneously to have diminished their spiritual content. Medieval theological commentaries became exercises in natural philosophy and logic. From time to time Church authorities sought to stem the tide by edicts that were intended to curtail, if not prevent, excessive reliance of theology on natural philosophy and logic. (56) Their efforts were in vain. Theology had become too dependent on logic and natural philosophy.

During the history of medieval Islam, a continual struggle raged among theologians, philosophers, and religious teachers. Only religious subjects constituted the curriculum of the madrasas, while the foreign sciences--logic, natural philosophy, and the exact sciences--were either ignored or taught only as ancillary subjects to shed light on religion. The university system in the Christian West was radically different. Universities taught a nonreligious analytic curriculum based on logic, science, and natural philosophy. So great was the surge toward analyticity, that theology was transformed into a large collection of problems that could only be resolved by the use of logic and natural philosophy. This practice continued routinely for four centuries and laid the basis for a rationalistic society.

Islam and the West differed not because one civilization taught, studied, and wrote about analytic subjects that the other ignored. Both civilizations taught, studied, and wrote about logic, natural philosophy, and the sciences. But in contrast with Islam, the West taught, studied, and wrote about these disciplines in universities that fully supported them. This was possible because the university curriculum was enthusiastically approved by church and state. Anyone with a university education had studied, and perhaps even commented on, Aristotle's natural philosophy and done so for its own sake, not for the sake of better understanding or explicating Scripture. In Islam, the foreign sciences, which comprised the analytic subjects derived ultimately from the Greeks, were rarely taught in religious schools such as the madrasas, which formed the core of Islamic higher education. The analytic subjects were there, though they were

marginal. But why were they marginal? Why did they not have equal status with religious and theological subjects? Why did they have to be taught as ancillary subjects, or taught privately and unobtrusively? We have now come full circle, since the answer to these questions requires reiteration of all the arguments and quotations that I have already presented. In light of the obstacles faced by natural philosophy in Islam, the high level of achievement that it attained is quite remarkable. But as long as religious traditionalists opposed or ignored analytic studies, they could not attain the required degree of acceptance to be a potent intellectual force in Islamic society.

I should like to conclude with a hypothetical scenario. Let us assume that a reassessment of the traditional interpretation of the madrasas should reveal that Islamic society did embrace analytic studies. What if it were shown that the madrasas laid heavy emphasis on rational subjects such as Aristotelian logic, natural philosophy, mathematics, and astronomy. And let us suppose that this rationalistic curriculum has been extremely stable since 1300, a period of seven hundred years! And like the West these rationalistic subjects had as one of their functions the explication of Islamic revelation. In effect, let us assume that Islam's educational system in the madrasas was as rationalistic as that which prevailed in the medieval Latin West.

If this should prove to be an accurate characterization of Islamic education since 1300, certain fundamental questions arise. Why did Islamic education remain so static for seven centuries, while in the West, the analogous curriculum, based on medieval Aristotelian learning, was largely abandoned in the seventeenth century, after approximately four centuries, to be replaced by a new approach to science that is associated with the Scientific Revolution? With the implementation of the new science in the West, why did Islamic scholars not appropriate what they could from the new science? Why did they continue on for centuries with an outmoded curriculum that had been abandoned in the West? Why did Islam not borrow the new science and learning from the West during the seventeenth to nineteenth centuries, just as the West had borrowed much of their science and natural philosophy from Islam in the twelfth and thirteenth centuries? Were Muslims too proud to borrow from the West? Were they fearful that Western ideas would endanger the faith? Were they simply uninterested? Or did they regard it as unimportant and perhaps even irrelevant? Did they regard the new science as adding little or nothing to the science they already had in the madrasas and beyond, and perhaps even viewed Western science as a step backward from that standard?

This last possibility would make the hypothesis of a rationalistic curriculum in the madrasas seem far-fetched and implausible. And yet Professor Seyyed Hossein Nasr is convinced that Islamic science is so radically different from Western science that it could not have profited from it. As Professor Nasr sees it, Islamic science was as important for religious and spiritual life, as it was for the acquisition of knowledge about the physical world. Islamic cosmological sciences not only provided "the necessary background and knowledge for particular disciplines of

practical import such as medicine and agriculture," but they had "a direct practical effect upon the inner life of man," because

they are directly related to man's real existential problem which is to traverse the perilous caves and valleys of the 'mountains' of the physical and psychic worlds to reach safely the sky of the world of the Spirit. (57) Continuing in the same vein, Professor Nasr explains that: The traditional cosmological sciences ... concern man in an ultimate sense and on a level not to be compared with the modern sciences. The traditional cosmologies are related to man's inner perfection and to his ultimate end. They are inseparable from angelology and eschatology. They provide the background for that process of spiritual maturing which enables man to become God's vice-regent in actuality rather than only potentially ... (58) For Seyyed Hossein Nasr science and religion merge, and even fuse, to form a vast spiritual enterprise. If his characterization of Islamic science is reasonably accurate, we might conclude that Muslims, satisfied with their own science, would have had no desire, and indeed, no need, to import Western science. Professor Nasr seems to regard Islamic science as the product of a more holistic approach, in contrast to the narrower, more focused science produced in the West. A recent investigation into cultural differences may offer some support to those who would distinguish between Western and Islamic science along cultural lines. Dr. Richard Nesbitt, a social psychologist at the University of Michigan, and his colleagues challenge the widely held view among Western philosophers and psychologists that "the same basic processes underlie all human thought, whether in the mountains of Tibet or the grasslands of the Serengeti." (59) The basic processes that all humans followed were alleged to embrace

a devotion to logical reasoning, a penchant for categorization and an urge to understand situations and events in linear terms of cause and effect. However, in comparing East Asians and European Americans, Dr. Nesbitt and his colleagues arrived at a radically different assessment. They "found that people who grow up in different cultures do not just think about different things: they think differently." Easterners, they discovered,

appear to think more "holistically," paying greater attention to context and relationship, relying more on experience-based knowledge than abstract logic and showing more tolerance for contradiction. Westerners are more "analytic" in their thinking, tending to detach objects from their context, to avoid contradictions and to rely more heavily on formal logic. This is an intriguing analysis and is compatible with Professor Nasr's understanding of Islamic science and certainly fits what we know about Western analyticity. But it would require a great deal more

investigation and discussion of medieval Islamic and Western natural philosophy and theology before we can assert with any confidence that the differences between them derive from cultural differences between East and West of the kind described by Dr. Nesbitt and his colleagues. In light of all these uncertainties, it seems proper to conclude that we are as yet unable to answer the most vital questions about the course of science in Islam. Was it the kind of science Professor Nasr has described: as much concerned with the spiritual world as with the physical world; or was it more akin to medieval Western science and natural philosophy, and therefore incorporating a strong current of rationalistic thought? If the latter, why did Islam ignore Western science for so long? Answers to such questions would contribute mightily toward a proper understanding of Islamic attitudes toward science and natural philosophy from the Middle Ages to the present.

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(1) See Reynold A. Nicholson, *A Literary History of the Arabs* (Cambridge: Cambridge University Press, 1953), 182.

(2) Edward Grant, *The Foundations of Modern Science in the Middle Ages* (Cambridge: Cambridge University Press, 1996), 183.

(3) See Tarif Khalidi, "The Idea of Progress in Classical Islam," *Journal of Near Eastern Studies* 40 (Oct. 1981), 280.

(4) A.J. Wensinck, *Concordance et Indices de la Tradition Musulmane* (Leiden/New York: E.J. Brill, 1936-1988), s.v. 'Zaman,' 'Umma.'" Cited in: Khalidi, "The Idea of Progress in Classical Islam," 279.

(5) A.J. Wensinck, *A Handbook of Early Muhammadan Tradition, Alphabetically Arranged* (Leiden: E.J. Brill, 1960), s.v. 'Hour,' where hadiths about knowledge disappearing in the last days are cited. Cited in: Khalidi, "The Idea of Progress," 279.

(6) See Lord Kinross, *The Ottoman Centuries: The Rise and Fall of the Turkish Empire* (New York: Morrow Quill Paperbacks, 1977), 381.

(7) Ibid.

(8) Ibid., 382.

(9) Ibid.

(10) Toby Huff, *The Rise of Early Modern Science* (Cambridge: Cambridge University Press, 1993), 69.

(11) Abdelhamid I. Sabra, "Science and Philosophy in Medieval Islamic Theology," in *Zeitschrift für Geschichte der Arabisch-Islamischen Wissenschaften*, vol. 9 (1994), 3.

(12) Sabra, "Science and Philosophy in Medieval Islamic Theology," 5.

(13) See *Philosophy in the Middle Ages: The Christian, Islamic, and Jewish Traditions*, ed. Arthur Hyman and James J. Walsh, (Indianapolis: Hackett Publishing Co., 1973), 205.

(14) Sabra, "Science and Philosophy in Medieval Islamic Theology," 9.

(15) Toby Huff, *The Rise of Early Modern Science*, 111.

(16) William Montgomery Watt, *Islamic Philosophy and Theology: An Extended Survey* (Edinburgh: University Press, 1985), 54.

(17) Ibid., 55.

(18) See Pervez Hoodbhoy, *Islam and Science: Religious Orthodoxy and the Battle for Rationality* (London: Zed Books Ltd, 1991), 99-100.

(19) For a good account, see George Makdisi, "Ash'ari and the Ash'arites in Islamic Religious History," Parts I and II, in *Studia Islamica*, vol. 17 (1962), 37-80; and vol. 18 (1963), 19-39. Reprinted in George Makdisi, *Religion, Law and Learning in Classical Islam* (Hampshire, Great Britain: Variorum Collected Studies Series; Brookfield, Vermont: Gower Publishing Co., 1991), I.

(20) George Makdisi, "Ash'ari and the Ash'arites in Islamic Religious History," Part II, in *Studia Islamica*, vol. 18 (1963), 22. Reprinted in Makdisi, *Religion, Law and Learning in Classical Islam*, I, 22.

(21) See Arthur John Arberry, *Revelation and Reason in Islam: The Forwood Lectures for 1956, Delivered in the University of Liverpool* (London: George Allen & Unwin Ltd.; New York: The Macmillan Co., 1957), 22.

(22) Ibid.

(23) Ibid., 23.

(24) Translated in William Montgomery Watt, *The Faith and Practice of al-Ghazali* (London: George Allen and Unwin Ltd, 1953), 33.

(25) Ibid.

(26) Ibid., 34.

(27) Cf. Al-Ghazali's *Tahafut al-Falasifah* [Incoherence of the Philosophers], trans. Sabih Ahmad Kamali (Pakistan Philosophical Congress Publication, No. 3, 1963), 249.

(28) Ibid., 3.

(29) Huff, *The Rise of Early Modern Science*, 68.

(30) Ignaz Goldziher, "The Attitude of Orthodox Islam Toward the 'Ancient Sciences,'" *Studies on Islam*, ed. and trans. Merlin L. Swartz (New York: Oxford University Press, 1981), 205.

(31) Ibid.

(32) Ibid., 206.

(33) See Pervez Hoodbhoy, *Islam and Science*, 111.

(34) Bernard of Clairvaux, *The Life and Letters of St. Bernard of Clairvaux*, trans. Bruno Scott James (London: Burns Oates, 1953), letter 249, p. 328.

(35) For a brief account of the reaction to Aristotle's works at the University of Paris, see Grant, *The Foundations of Modern Science in the Middle Ages*, 70-80.

(36) Averroes, *On the Harmony of Religion and Philosophy*, A translation with introduction and notes, of Ibn Rushd's *Kitab fasl al-maqal*, with its appendix (*Damima*) and an extract from *Kitab*

al-kashf 'an manahij al-adilla, trans. George F. Hourani (London: Luzac, 1976), 44.

(37) Ignaz Goldziher, "The Attitude of Orthodox Islam Toward the 'Ancient Sciences,'" 205.

(38) My information about al-Razi is drawn from the article "Al-Razi, Abu Bakr Muhammad Ibn Zakariya" by Shlomo Pines in the Dictionary of Scientific Biography (New York: Charles Scribner's Sons, 1970-90), vol. 11, 323-6.

(39) Ibid., 326.

(40) Averroes, On the Harmony of Religion and Philosophy, 24.

(41) Franz Rosenthal, "Ibn Khaldun," in Dictionary of Scientific Biography, vol. 7 (1973), 321.

(42) Toynbee's assessment of Ibn Khaldun is cited in An Arab Philosophy of History: Selections from the Prolegomena of Ibn Khaldun of Tunis (1332-1406), trans, and ed. Charles Issawi (Princeton, NJ: The Darwin Press, 1987), ix. Toynbee's remarks were taken from his A Study of History, vol. 3.

(43) George Sarton, Introduction to the History of Science (Baltimore: Williams & Willins Company, 1927-1948), vol. 3, 1775.

(44) Article "Madrasa" in Encyclopedia of Islam, vol. 5, 1128, col. 2.

(45) See George Makdisi, The Rise of Colleges: Institutions of Learning in Islam and the West (Edinburgh: Edinburgh University Press, 1981), 36.

(46) Ibid., 77.

(47) Ibid., 78.

(48) Cf. Roy Mottahedeh, *The Mantle of the Prophet* (New York: Pantheon Books, 1985), 237

(49) On the subject of logic in Islam, see John Walbridge's excellent article, "Logic in the Islamic Intellectual Tradition: The Recent Centuries," in *Islamic Studies*, 39, No. 1 (Spring 2000), 55-75. On attitudes toward philosophical logic, see p. 68.

(50) Mottahedeh, *The Mantle of the Prophet*, 91.

(51) For a brief description of the medieval university and its faculties and curriculum, see Grant, *The Foundations of Modern Science in the Middle Ages*, ch. 3 ("The Medieval University"), 33-53. For a lengthy, detailed account, see H. de Ridder-Symoens, ed. *A History of the University in Europe*, vol. 1: *Universities in the Middle Ages* (Cambridge: Cambridge University Press, 1992).

(52) "Quarto quaeritur utrum Deus possit simul contradictoria facere." Richard of Middleton, *Clarissimi theologie magistri Ricardi de Media Villa, Super quatuor libros Sententiarum Petri Lombardi questiones subtilissimae*, vol. 1, bk. 1, dist. 42, qu. 4, pp. 374 (col. 1)-375 (col. 2); cited from Facsimile Reprint: Frankfurt: Minerva, 1963.

(53) Hugolini de Urbe Veteri OESA *Commentarius in Quattuor Libros Sententiarum*, edited by Willigis Eckermann O. S. A., 4 vols. (Wtirzburg: Augustinus Verlag, 1980-1988), Vol. 2: Book 1, Distinction 40, Question 3, art. 3, 341.

(54) Hugolin of Orvieto, *ibid.*, Vol. 3: Book 2, Distinction 2, Unique question, art. 3, 97-9.

(55) Gregorii Arimensis OESA Lectura super Primum et Secundum Sententiarum, 7 vols. (Berlin: Walter de Gruyter, 1979-1987), vol. 3, bk. 1, distinctions 42-4, qu. I, 359.

(56) For a summary account of the reaction of churchmen to the invasion of theology by natural philosophy and logic, see Monika Asztalos, "The Faculty of Theology," in H. de Ridder-Symoens, ed. *A History of the University in Europe*, vol. 1: *Universities in the Middle Ages* (Cambridge: Cambridge University Press, 1992), 420-33.

(57) Seyyed Hossein Nasr, *Islamic Science: An Illustrated Study* (Westerham, Kent, England: World of Islam Festival Publishing Co. Ltd., 1976), 236.

(58) *Ibid.*, 237. Professor Nasr also believes that modern science, that is Western science, has led to the destruction of nature. By contrast, "... Islamic metaphysics and cosmology were able to create an extensive science of the physical and of the psychic worlds which far from destroying nature only accented the equilibrium that exists in the cosmic order and emphasized the harmony between man and his environment. While the Islamic sciences taught man a great deal about the world about him and enabled man to rule over this world, they also set limits to his power to destroy the earth and pointed in a thousand ways to the fact that man's end is to journey to a world beyond and not to be satisfied through pride or ignorance with imprisonment within the cosmic crypt which man's forgetfulness has made to appear as his natural state" (*Ibid.*, 239).

(59) Erica Goode, "How Culture Molds Habits of Thought," *Science Times*, *New York Times*, August 8, 2000. All the quotations in this paragraph are from Ms Goode's article.

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